D0 Note 4651

Redressing the BLS Trigger Cables for the Run IIb L1 Calorimeter Trigger Upgrade

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Abstract

For the Run IIb upgrade of the L1 calorimeter trigger, a transition system will be used to transport the signals from the existing trigger cables to the new electronics. This note discusses the rearrangement of the irreplaceable trigger cables, and the installation of the intermediaries between the trigger cables and the new electronics. A mock-up was constructed to determine the mechanical issues and constraints that may be encountered during the actual installation.

I. Introduction

As part of the Run IIb upgrade [1], the calorimeter trigger electronics on the first floor of the moveable counting house (MCH) will be replaced, while the trigger cables[1] will be reused.   However, the existing trigger cables cannot be plugged directly into the new electronics, so a transition system has been designed. More details on the cabling and the transition system can be found in D0 Note 4430 [2]. The impedance matching and frequency analysis of the trigger cables and the transition system was studied and reported in D0 Note 4692 [3]. Labelling of cables and associated components is described in D0 Note 4768 [4].

The existing trigger cables were installed at the very beginning of Run I [5]. There are two types of trigger cables used to run from the baseline subtractor (BLS) cards in the platform to the L1 Cal trigger electronics in MCH1. One of them was made by a company called ASTRO, and the other was made by a company called New England Wire. Most of the trigger cables have a blue-colored shielding, but some of the cables from the very forward Calorimeter (high eta) have a gray-colored shielding. The trigger cables are made of 0.1" diameter ribbon coaxial cable with 16 coaxials per ribbon. Four adjacent coaxial cables carry the differential electromagnetic (EM) and hadronic (HD) signals for one Trigger Tower (TT).   The lengths are: 130 feet (39.6 m) to the north end calorimeter (ECN), 150 feet (45.7 m) to the central calorimeter (CC), and 180 feet (54.9 m) to the south end calorimeter (ECS).

In the front of each of racks MCH103-112, the cables emerge from the floor and run along a pair of cable guides (Figure 1). The trigger cables are bundled with cable ties in groups of four. Each cable is connected to the electronics for a single trigger tower with a unique eta and phi coordinate. The absolute trigger eta coordinate increases from left to right, and the trigger phi coordinate increases from top to bottom. Each rack receives the trigger signals of four consecutive trigger eta coordinates over all phi space (Figure 2).

The current and future rack layout of the south aisle in MCH1 is shown in Figure 3. In the current Run I L1 CAL trigger system, there are 128 trigger cables plugged into the electronics along the full height of each of racks M103-112 (Fig. 3, top). The Run I electronics are represented by a pair of crate-like boxes in each rack. In the new Run IIb L1 CAL trigger system, the signals from the 1280 trigger cables will be routed to one of only four new crates via patch panels (Fig. 3, bottom). The color coding in Fig. 3 illustrates the translation of the signals from the old electronics which uses twenty crates to the new electronics which will use only four crates.

[1] Trigger cables are also referred to as baseline subtractor (BLS) cables as they originate from the calorimeter BLS racks inside the detector platform and run to the MCH racks 103-112.

Figure 1. a) One of the Run I L1 CAL trigger racks in MCH1 and b) a ribbon of four trigger cables. All of the Run I electronics, non-trigger cables and power supplies in the rack interiors will be removed to make way for the Run IIb L1 CAL trigger system. Only the trigger cables (blue in these photots) will be reused.

Figure 2. Rack layout of the Run I electronics [6]. The L1 CAL trigger signals are carried by 128 trigger cables to each of the ten racks.

Figure 3. Rack layout for the L1 calorimeter trigger electronics on the south aisle of the first floor of MCH for the current (Run I) system (top) and the upgrade (Run IIb) system (bottom). The color code illustrates the translation of signals from the current to the upgrade electronics [7].

The transition system passively transfers the signals from the trigger cables to the Analog-to-Digital Filter (ADF) crates [2, 8]. A Patch Panel Card (PPC) receives the input signals from 16 trigger cables and sends the ouput along a pair of Pleated Foil Cables (PFC) to one ADF Transition Card (ATC) which plugs directly into the ADF crate backplane. Eight PPCs are needed for each rack, and will be mounted in pairs on four patch panels which will be installed in the bottom third of all of racks M103-112 (Fig. 3, bottom). The transition system design will allow the trigger cables to remain within the same Run I rack locations.

Before the Run I electronics can be removed from racks M103-112, the trigger cables will need to be disconnected from the electronics, relabeled to reflect the new configuration, and then placed carefully in the cable holders which are mounted along the full height on the front of each rack (Figure 1). These actions will protect the trigger cables from accidental damage during the estimated 3-4 week period in which the Run I electronics will be removed, the power, cooling and saftey services will be replaced and the Run IIb electronics will be installed.

After the Run IIb electronics are installed, the trigger cables will be recovered from the cable guides. Then, a careful and significant effort will be required in order to redress the short lengths (less than 1 meter) of exposed trigger cables before they can be plugged into the transition system. In order to understand what mechanical difficulties may be encountered, a mock-up was constructed to simulate on a small scale the routing, redressing, relabelling and strain relief of the trigger cables, as well as the mounting, location and access of the patch panels. Bundles of scrap cable, identical to the existing trigger cables, were used to study the cabling. Prototypes of the patch panels and patch panel cards were used in the mock-up of one rack, e.g. M103. The effort is summarized, and a procedure is recommended for the actual installation.

The mock-up was performed at the L1 CAL Sidewalk Test Stand (Figure 5) which is adjacent to MCH on the first floor of the D0 Assembly Building (DAB). To simulate what installers will face after the existing L1 calorimeter trigger racks are stripped of all components except the trigger cables, an empty rack was relocated to the sidewalk, and cable holders mounted to the front.

Figure 5. a) Sidewalk area adjacent to MCH on the first floor of the DAB, b) an empty rack with cable holders on the front and c) scrap cable for the mock-up.

II. Disconnecting and Relabelling the Trigger Cables

The Run I trigger cable configuration is shown in Figure 1a. Several ribbons of scrap cable were cut to specific lengths, bundled in groups of four and then cable tied in order to simulate the 128 trigger cables one would encounter in any given MCH1 L1 CAL rack. Figure 6 shows a mock-up of one super bunch of 32 trigger cables. There are four super bunches within each rack, and the super bunches alternate from left to right as they enter the rack from the cable holders along the front of the racks.

All of the visible cable ties need to be removed. One needs to be very careful as t is very easy to damage the trigger cables while cutting the cables ties. The preferred method for cutting the cable ties is shown in Figure 7. The cable tie should be cut at the head, and not along the length which had direct contact to the trigger cable. It is more work to cut at the head, but a lot less work that running new trigger cables from the calorimeter out to the trigger electronics.

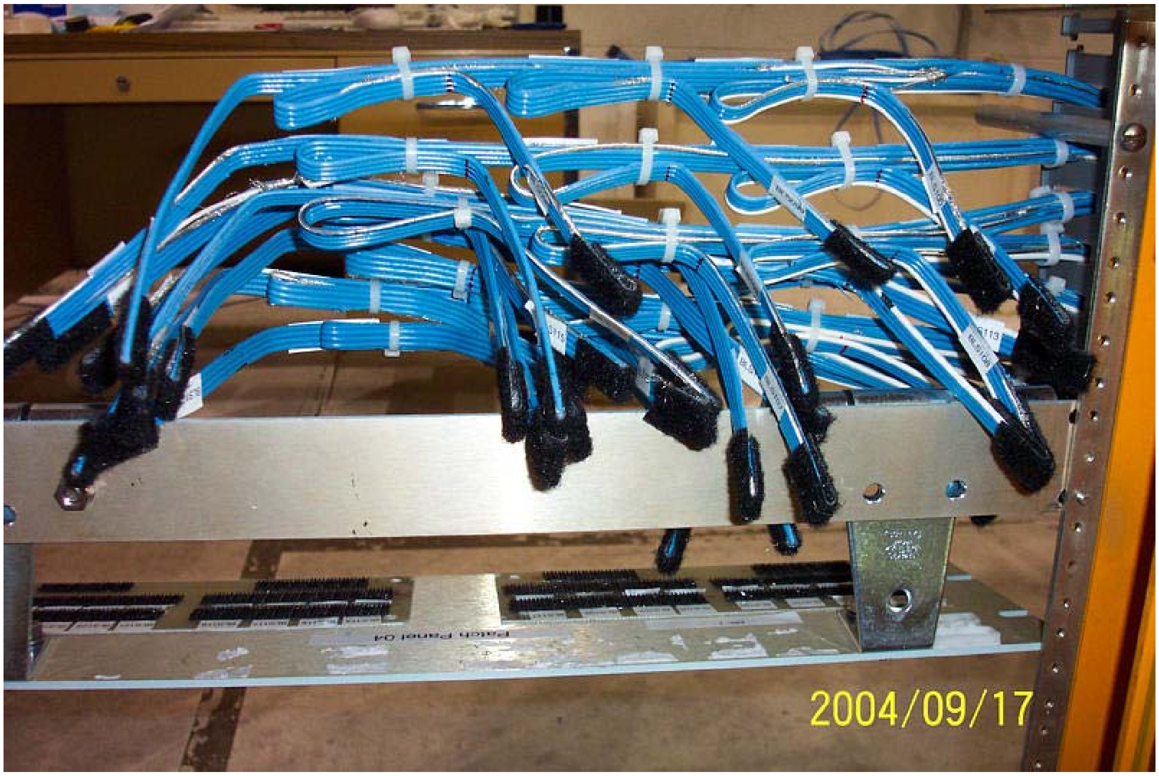

Figure 6. Mock-up of one super bunch of 32 trigger cables including cable ties as it appears in the Run I L1 CAL trigger configuration in MCH1.

As the trigger cables are disconnected from the old electronics, new labels will be placed on the MCH1 end of trigger cables[2]. Each label will contain a unique cable name, the place of origin and the place of destination [4]. The 1280 trigger cabels are labelled L1CAL_R2B_BLS0001 through L1CAL_R2B_BLS1280. The origin gives the rack, crate and trigger tower (eta, phi) in the detector platform. The destination is a jack connector on one of two patch panel cards mounted to one of four patch panels in one of ten racks. An example of the new labels is illustrated in Figure 8. The user information is contained with the label flag which has a white background. The longer label tail is transparent so it can wrap around the flag without obscuring the information.

As the cable ties are removed, and the new labels are attached, the bundles of four are wrapped about every foot with a strip of electrical tape over the visible length, starting from the where the cables leave the cable holders. No tape is placed on or around the connectors, and the cable labels should remain unobscured. Next, the volume of trigger cables is placed carefully into the cable holders on the front of the racks. No effort at this stage is made to remove any cable slack.

[2] The trigger cables at the Calorimeter BLS end are inaccessible. The Run I labels will not be removed or covered ,although the information on the Run IIb labels will supercede the Run I labels.

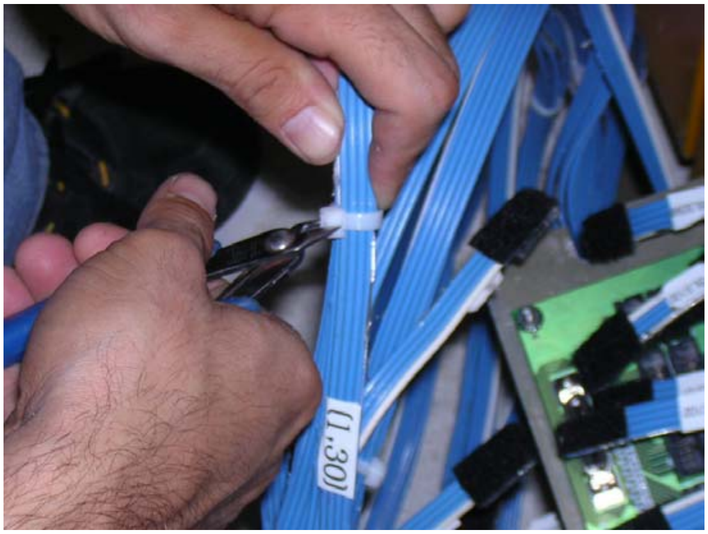

Figure 7. The cable ties in the Run I trigger cable configuration should be removed by cutting at the cable tie head.

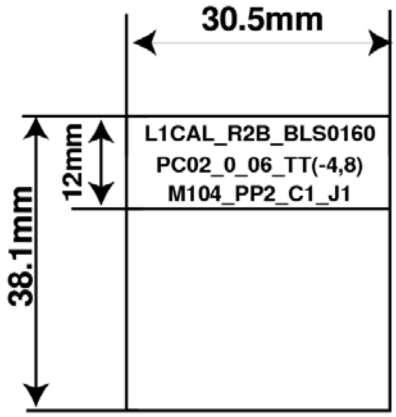

Figure 8. Example of a Run IIb L1 CAL BLS trigger cable label. The 12 mm flag contains the label name, the place of origin and the place of destination [4].

III. Patch Panels and Patch Panel Cards

In the Run IIb rack configuration, four patch panels are needed in each of racks M103-112. A schematic of racks M103-105 is shown in Figure 9. In the racks adjacent to the rack which contains an ADF crate, the patch panels are installed at a higher position to equalize the path length of the pleated foil cables.

For the mock-up, bulkhead plates were mounted on hinges which rotate from the full vertical position to almost horizontal to provide easy access to the patch panel cards from the front of the racks. The hinged bulkhead plates are called patch panels; four patch panels (PP1-PP4 in Fig. 9) are needed for each rack. The hinges attach to the bottom of the patch panels. Two patch panel cards (C1-C2 in Fig. 9) are mounted on each patch panel. Although the final patch panel appearance is different than the prototype shown in Figures 10, the functionality is the preserved, and the following procedure is the same.

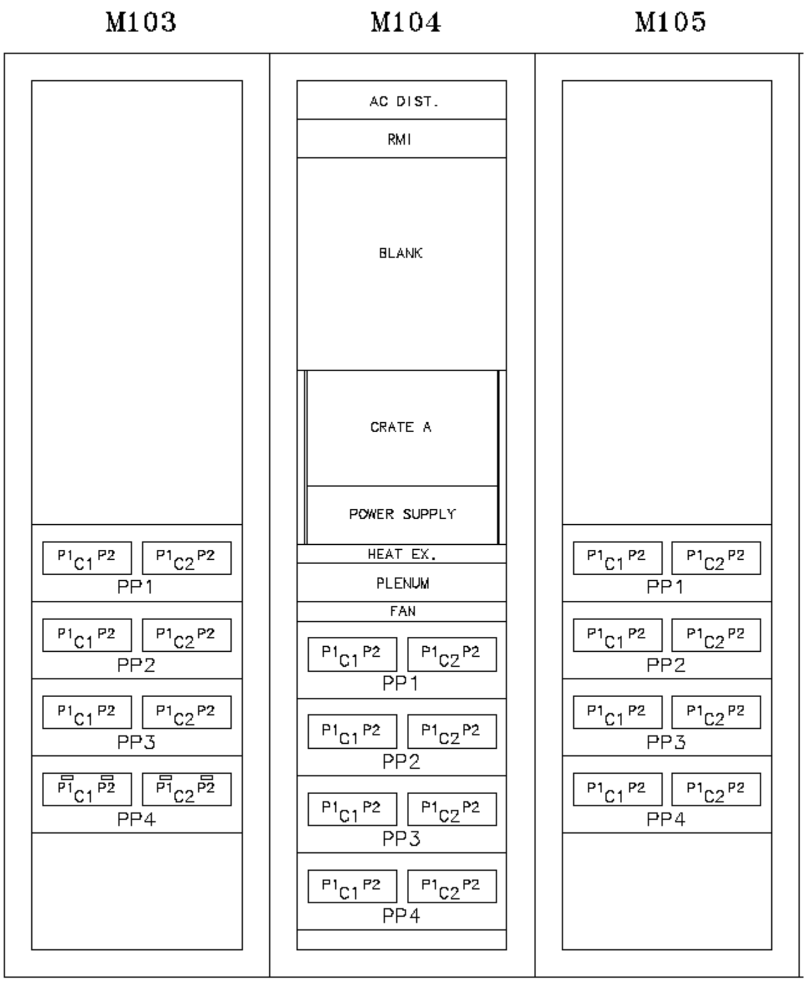

Figure 9. Final schematic of the Run IIb configuration for racks M103-105. Four patch panels (PP) are needed for each rack [7].

The patch panel card is a passive electronics card which directs the input from sixteen trigger cables to the output to two pleated foil cables. In addition, there are four connectors on the opposite side of card for monitoring the signal (and ground) connections on an oscilloscope. Figure 11 shows the patch panel card schematic. The trigger cables plug into the input jack connectors (J1-J8, J11-J18).

Figure 10. The a) front view and b) rear view of the prototype design of the patch panels.

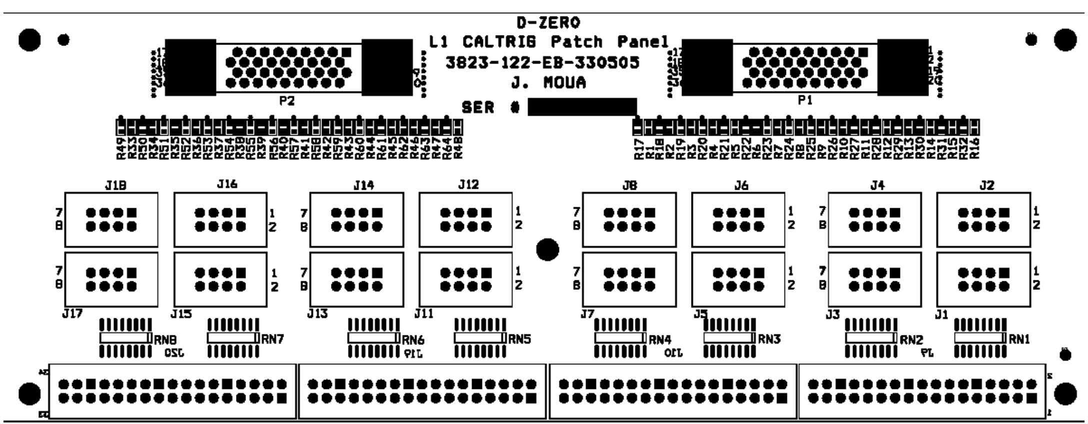

Figure 11. Final schematic of the patch panel card. The trigger cables plug into the sixteen central connectors (J1-J8, J11-J18). The pleated foil cables plug into the two top connectors (P1-P2). The bottom connectors are for monitoring of all signal and ground connections [7].

IV. Reconnecting and Redressing the Trigger Cables

First and foremost, the screw holes along the rack side rails should be measured and clearly marked according to Figures 9 and 12. Each patch panel is 4U (7 inches) in height.

The following procedure was determined to be much easier if one starts from the lowest patch panel, install the patch panel cards, route, connect and strain relief the trigger cables, then move up to the next patch panel, etc. until all four patch panels and associated cards and cables are mounted and connected.

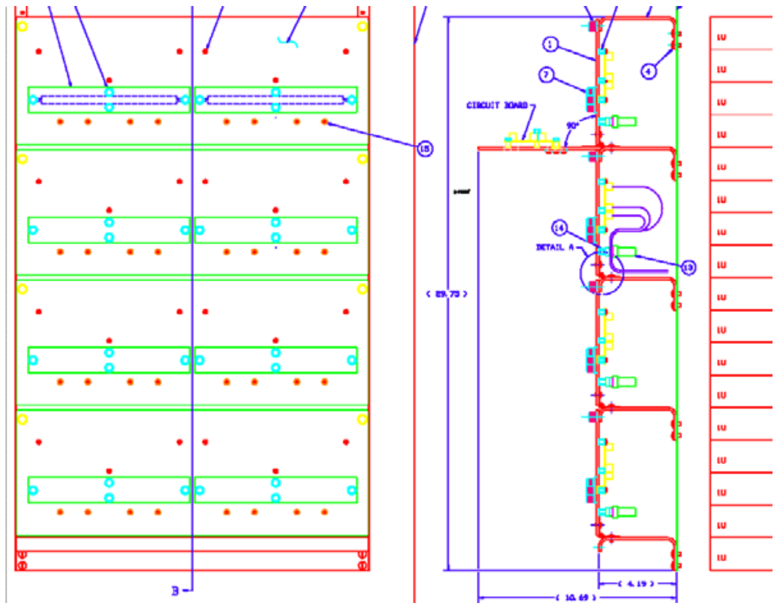

Figure 12. Final schematic of the (a) front and (b) side layout of the patch panel system for one Run IIb rack [7]. Each patch panel is 4U (7 inches) in height.

After installing the first patch panel near the bottom of the rack, mount a pair of patch panel cards, each with five screws (Figure 13a). Next, the bundles of cable will need to be routed to the patch panel cards. Figure 13b shows how the trigger cables should emerge from their cable holder. One should start with the lowest cables and work on up to the higher ones.

Each slot in the cable holder will contain either one or two bundles of four trigger cables. One should spread each bundle out into layers of two cables, so that there are not four cables wedged into the cable holder slot, but rather at most two cables on top of each other. This will ease the strain on the cables. This can be seen in the top right of the following picture. Each slot will hold two bundles of four trigger cables, which means four groups of two cables stacked on top of each other, a grand total of eight trigger cables per slot (Figure 13b). The slots in the cable holder are separated by about 1U, so the separation of four slots is about the same as the height of a patch panel.

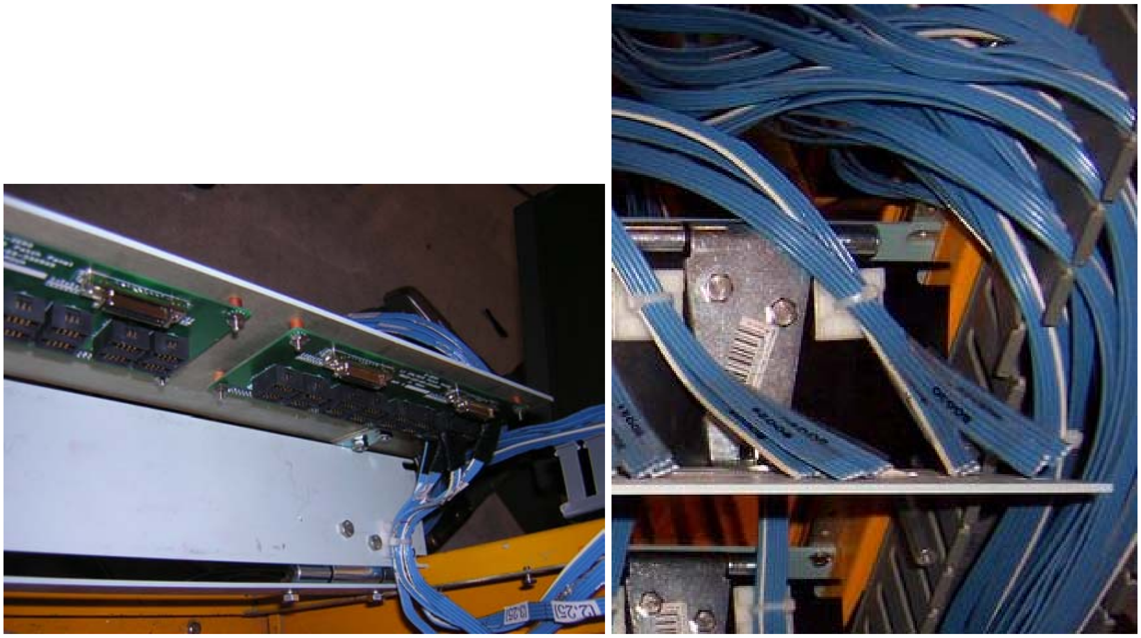

Figure 13. (a) Two mounted patch panel cards with the first bundle of four trigger cables routed. (b) Trigger cables are stacked in pairs as they emerge from the cable holder.

For the mock-up, a system to fix and strain relief the trigger cables was improvised with plastic cable ties and mounts (Figure 14 a-b). In the final system (devised after the mock-up was completed), screw mounted brackets with soft foam and removable covers will be used for the strain relief (Figure 15 a-b).

Figure 14. (a) Mock-up of a patch panel with cable mounts for strain relief. (b) Four trigger cables are routed to their approximate positions and fixed with cable ties.

When routing the trigger cables, one should start with the bundles that will plug into the patch panel card closest to the side where the trigger cables emerge from the cable holder. Any excess cable should be directed to the now empty interior of the rack. There will be much more cable slack for the upper two super bunches since they will have the most vertical displacement from the Run I to Run IIb positions. All effort should be made to bend the trigger cables as little as possible.

Figure 15. (a) Final patch panel design with the patch panel folded down for access to the pair of patch panel cards. (b) A set of four trigger cables are shown along with the a pair of pleated foil cables connected to one patch panel card. The brackets are mounted to the patch panel with screws. The bracket covers are removable.

After each bundle of four trigger cables has been routed to their respective positions, the trigger cables will need to be reordered. Each bundle will have the same phi coordinate, and four consecutive eta coordinates. Initially the bundle will have either the highest |eta| on top of the bundle, running down to the lowest for those bundles emerging from the left hand side of the rack, or it will be reversed for those bundles emerging from the right hand side of the rack. For example, suppose the bundle has the eta range of +1 through +4 for an arbritrary phi coordinate. In this case, the trigger cables carrying eta of 1 and 3 will need to be on the bottom, and 2 and 4 will need to be on the top (Figure 11). One should not flip or twist any trigger cables. For your bundles coming from the left side of the rack put trigger cable carrying eta of 4 on top, followed by 2, then 3, and finally 1 on the bottom. For the bundles from the right, start with 2 on top, followed by 4, then 1, and finally 3 on the bottom. This is done to minimize contortions in the cable. The next bundle (in the same rack) will have the same eta range, and the phi coordinate will increment by one.

Care is needed when plugging the trigger cables into the patch panel cards. It is easy to bend the pins.

After the trigger cables are installed and the strain relief applied, some amount of excess cable will be floating around inside the rack. The trigger cables should already be bundled in groups of four. The trigger cables should be further bundled into superbunches to make the excess volume neat and manageable. Figure 16 shows the completed cabling and patch panel mock-up for one rack.

Figure 16. Photographs of the completed cabling and patch panel mock-up for one rack.

V. Conclusions

This note gives a procedure for redressing the trigger cables for the Run IIb upgrade. Particular attention has been given to insure that the trigger cables have proper strain relief and that the correct channel mapping is implemented, all the while minimizing the rmovement of the trigger cables from their Run I to Run IIb positions. However, the trigger cables are about twenty years old. Therefore, in proceeding with the upgrade of the L1 Calorimeter Trigger System, there is unavoidable risk in disconnecting the trigger cables from the Run I electronics, clipping cable ties, routing them to the cable guides, rebundling them, rerouting them to the patch panel cards, and applying the strain relief system. The greatest worry is that a single coaxial wire could break thus eliminating a particular EM or HAD component of a trigger tower for all of Run IIb. However, if one follows the procedure described in this note, this type of problem is very unlikely to happen.

Finally one problem that may still present itself is that a wire may recede within the cable shielding and lose contact with the connector. If this happens one will need to clip off the connector end and then reconnectorize. The connectors are in principal reusable. This type of problem can be checked using the Calorimeter electronics pulser and an oscilloscope plugged into the monitor connectors of the patch panel. In Run I, about 10% of the trigger cables were reconnectorized after installation due to this type of problem.

VI. References

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